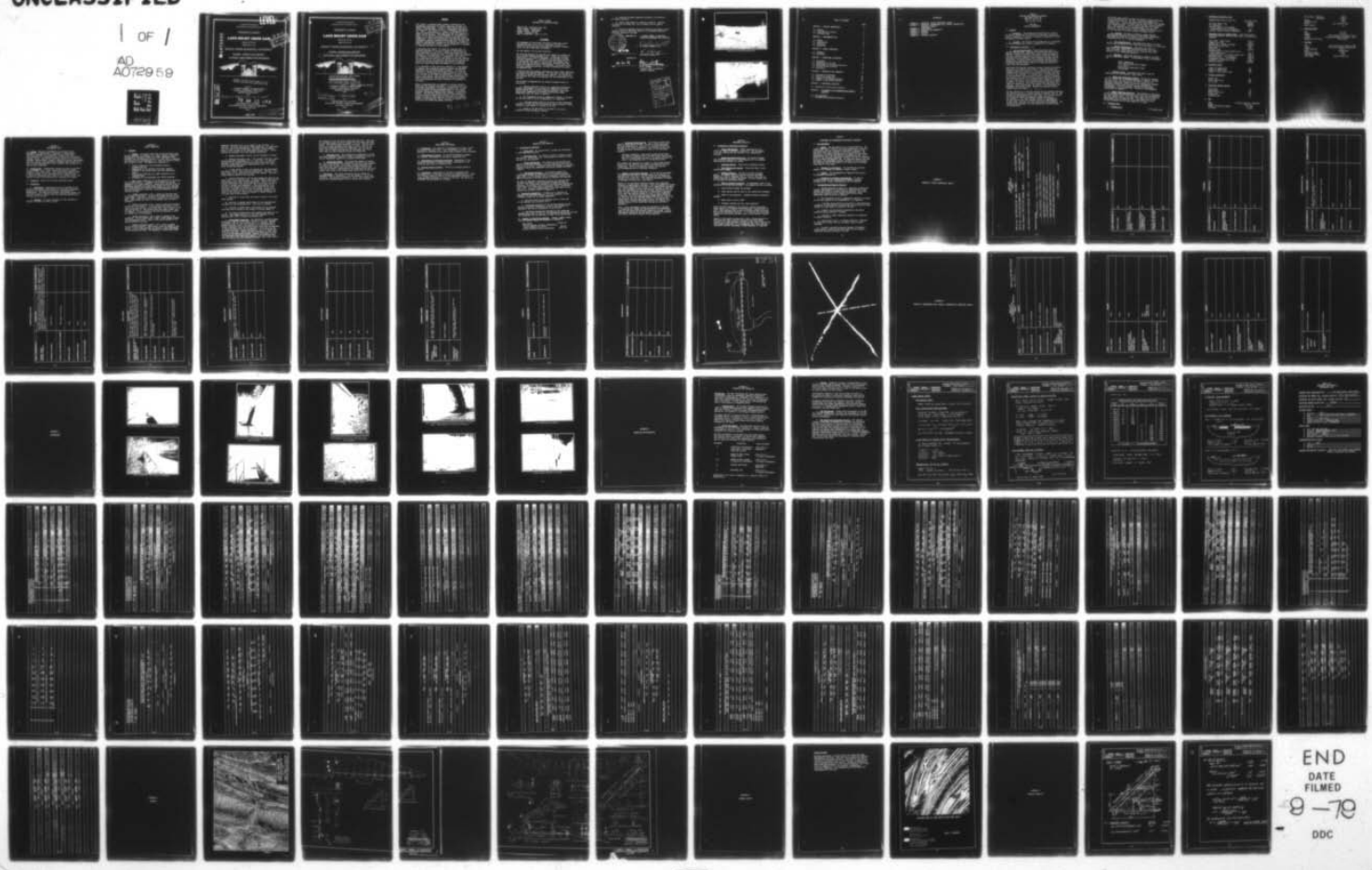
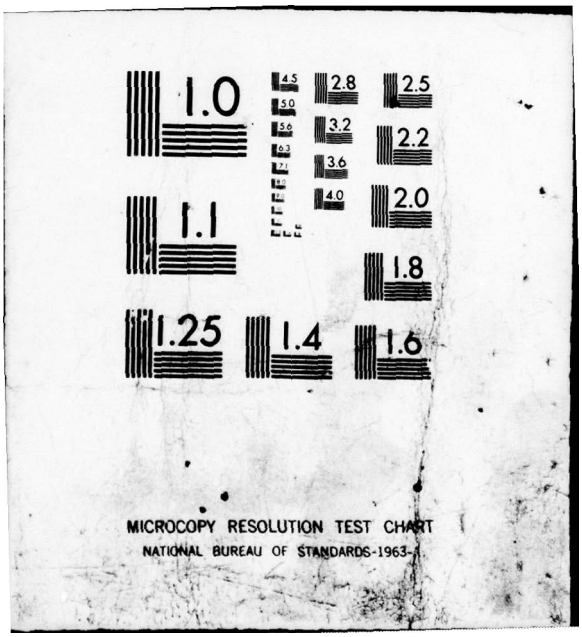
AD-A072 959 KIMBALL (L ROBERT) AND ASSOCIATES EBENSBURG PA F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. LAKE MOUNT UNION DAM, NDS ID N--ETC(U)
JUN 79 R J KIMBALL, K CHUANG DACW31-79-C-0009

UNCLASSIFIED NL

1 OF 1
AD A072959



END
DATE FILMED
9-79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL II

SUSQUEHANNA RIVER BASIN

SINGERS GAP RUN, HUNTINGDON COUNTY

PENNSYLVANIA

LAKE MOUNT UNION DAM

NDS ID NO. PA-473

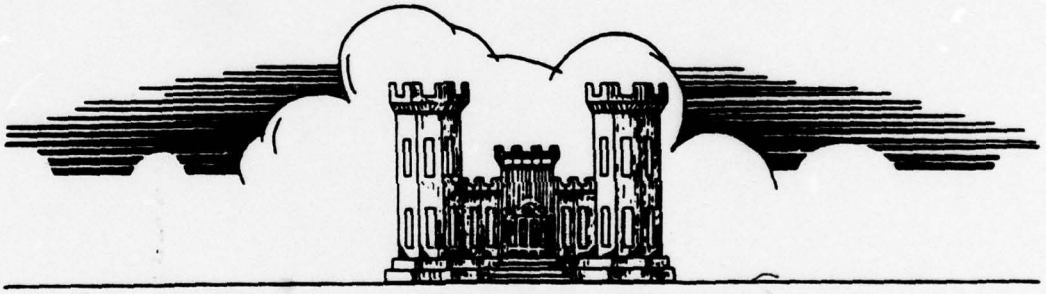
DER ID NO. 31-52

AD A072959

MOUNT UNION MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

Prepared By

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG, PENNSYLVANIA
15931

Contract #DACW31-79-C-0009

FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

JUNE, 1979

SUSQUEHANNA RIVER BASIN

SINGERS GAP RUN, HUNTINGDON COUNTY

PENNSYLVANIA

LAKE MOUNT UNION DAM

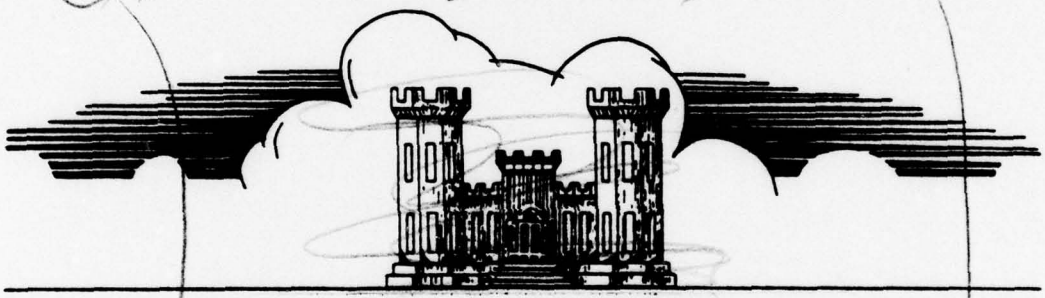
NDS ID NO. PA-473

DER ID NO. 31-52

MOUNT UNION MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



Lake Mount Union Dam. NDS ID Number PA-473. DER ID Number-31-52. ~~Mount Union Municipal Authority.~~ Susquehanna River Basin, Singers Gap Run, Huntingdon County, Pennsylvania.

Prepared By Phase I Inspection Report.

L. ROBERT KIMBALL & ASSOCIATES

CONSULTING ENGINEERS & ARCHITECTS

EBENSBURG, PENNSYLVANIA

15931

(10) R. Jeffrey /Kimball

Kuang-hwei /Chuang

(15) DACW31-79-C-0009

FOR

DEPARTMENT OF THE ARMY

BALTIMORE DISTRICT CORPS OF ENGINEERS

BALTIMORE, MARYLAND

21203

(11) JUN[illegible]79

(12) 79 p.

This document has been approved for public release and sale; its distribution is unlimited.

79 08 15 086

411 059

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM: Lake Mount Union Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Huntingdon
STREAM: Singers Gap Run
DATE OF INSPECTION: April 16, 1979

ASSESSMENT

The assessment of Lake Mount Union Dam is based upon visual observations made at the time of inspection, review of available records and data, hydrologic and hydraulic computations, and past operational performance.

The dam appears to be in good condition.

The existing spillway and reservoir are capable of passing only 8% of the PMF (Probable Maximum Flood). Based upon criteria established by the Corps of Engineers, the spillway is termed seriously inadequate. If Lake Mount Union Dam should fail due to overtopping, the hazard to loss of life and property downstream from the dam would be significantly increased from that which would exist just prior to overtopping. As a result of the seriously inadequate spillway, the dam is considered an unsafe, non-emergency dam.

A detailed study and remedial modifications should begin immediately to increase the spillway capacity. For this dam, it will not be sufficient to merely increase spillway capacity. The stability of the structure will have to be analyzed for any modification of the spillway.

The following recommendations and remedial measures should be instituted.

1. Perform additional studies by a registered professional engineer knowledgeable in dam design for modification of the spillway and/or dam to increase spillway capacity. This study should begin immediately and remedial modifications begun immediately after the study is complete.

2. The flashboards should be immediately removed to increase the spillway capacity until recommendation 1 is completed.

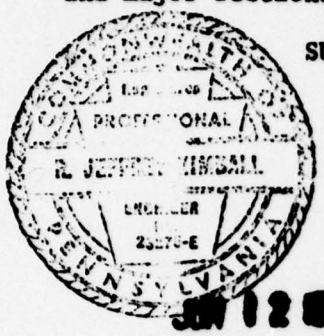
3. A warning system should be instituted to warn downstream residences of high spillway discharges and during periods of heavy rainfall or high runoff, or failure of the dam.

4. Access to the dam should be improved so the dam is accessible during periods of flooding.

5. Institute a formal inspection program to be conducted at regular intervals.

6. Repair drain lines to a workable condition. Exercise all gates on the drain line and the supply line at regular intervals.

7. Perform a detailed structural analysis (including a stress analysis) using the PMF water level for all probable conditions and major sections of the dam.



SUBMITTED BY: L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS

R. Jeffrey Kimball

R. Jeffrey Kimball, P.E.

JUN 12 [redacted]

Date

K. Chuang

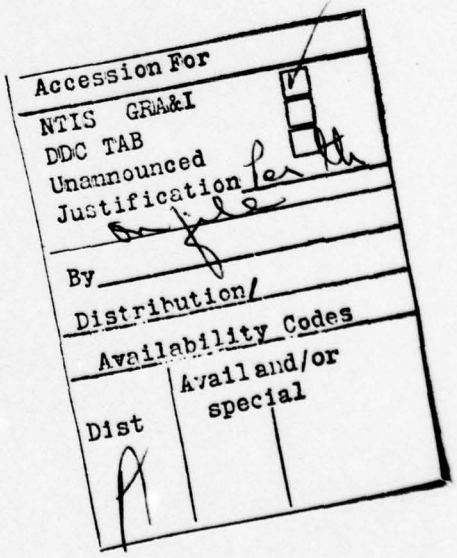
Kuang-hwei Chuang, P.E.

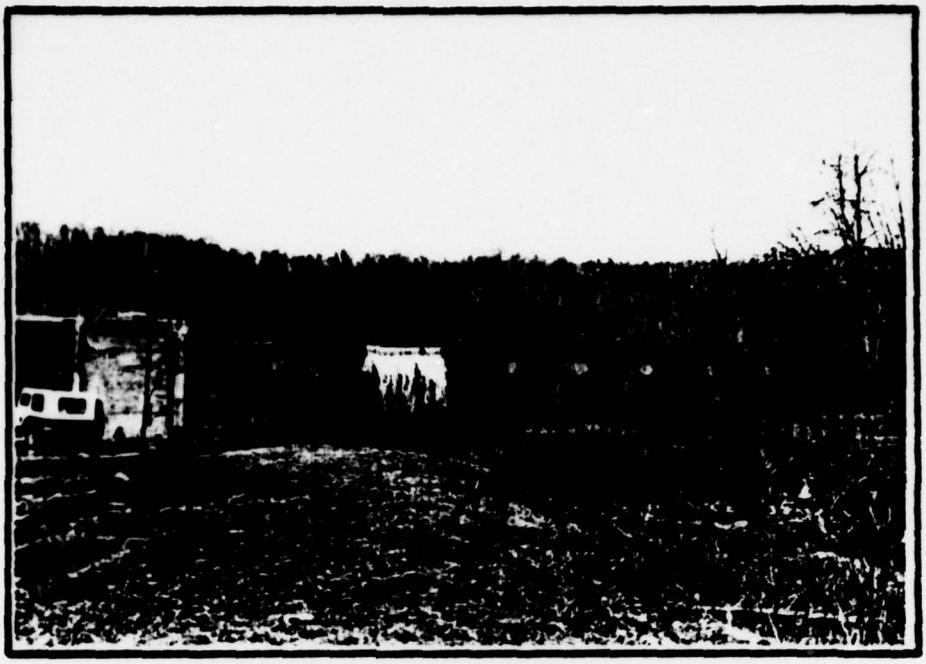
APPROVED BY:

28 Jun 79

Date

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer





Overview of dam from downstream.

Overview of dam from left abutment.

TABLE OF CONTENTS

APPENDICES

PHASE I
NATIONAL DAM INSPECTION PROGRAM
LAKE MOUNT UNION DAM
NDI I.D. NO. PA 473
DER I.D. NO. 31-52

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lake Mount Union Dam is a concrete buttress dam. Lake Mount Union Dam was built by the Ambursen Construction Company and is thus called an Ambursen type dam. Ambursen dams are articulated, reinforced concrete buttress dams with expansion joints between the decks and the buttresses. The deck consists of reinforced concrete water bearing slabs, separated by buttress tongues and supported by reinforced concrete haunches which are constructed monolithically with the buttresses.

Lake Mount Union Dam has seventeen vertical concrete buttresses constructed on eighteen foot centers. These buttresses are founded on shale and quartzite. The buttresses are of variable thickness with the bottom of each buttress 21 inches thick and the top of the buttress 14 inches thick. The concrete slab on the upstream of each buttress is also of variable thickness. The bottom of the slab is 41.5 inches thick with the top of the slab 24 inches thick. The concrete slab is sloped at an angle of 1H:1V. At the toe of the upstream slope of the dam a cutoff trench was excavated. This cutoff trench was backfilled with concrete. Steel reinforcing was placed in all buttresses and throughout the concrete slab. Between all expansion joints, asphalt putty was placed.

The dam consists of an overflow section and two abutment sections. The overflow section is located between buttresses 5 and 16. The spillway is approximately 193.5 feet long. The overflow section of the dam has wooden flashboards to raise the level of the reservoir. The right abutment section is approximately 81 feet long and the left abutment section is approximately 29 feet long. The dam is 51 feet high above the foundation. The foundation and abutment rock were extensively grouted during the construction.

The outlet works consist of three 16" pipes at various elevations on the upstream face of the dam. These three intakes are connected to a 12" cast iron supply line which flows to the Borough of Mount Union. Each 16" intake line has a gate valve to control flow through the line. The 12" supply line has a 12" blowoff line. The reservoir can be drained through a 30" cast iron drainline. The supply line is located between buttresses 4 and 5 and the drainline is located between buttresses 5 and 6.

b. Location. The dam is located on Singers Gap Run, approximately six miles southwest of Mount Union, Pennsylvania. Lake Mount Union Dam can be located on the Butler Knob, Pennsylvania U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Lake Mount Union Dam is an intermediate size structure (51 feet high-structural height, 211 acre-feet).

d. Hazard Classification. Lake Mount Union Dam is a high hazard dam. Downstream conditions indicate that loss of life is probable should failure of the structure occur (see Section 3.1e for downstream exposure).

e. Ownership. Lake Mount Union Dam is owned by the Mount Union Borough Water Company. Correspondence should be addressed to:

Water Commissioner
Mount Union Borough Water Company
P. O. Box 90
Mount Union, Pennsylvania 17066
814-542-4051

f. Purpose of Dam. Lake Mount Union Dam is used for water supply for the Borough of Mount Union.

g. Design and Construction History. The dam was designed by D.W. Dillman and the Ambursen Construction Company. The dam was built over a two year period from 1926 to 1927 by the Ambursen Construction Company and the Pitt Construction Company. Continuous inspection was provided by the Commonwealth of Pennsylvania. Very good records, drawings and photographs are available of the construction. The date of the flashboard installation is unknown.

h. Normal Operating Procedures. The reservoir is maintained at the spillway crest elevation with the excess inflow discharging over the spillway crest. In recent years, only the top intake on the water supply line has been used. The middle valve on the water supply line is broken and the bottom intake is silted. The main drainline has not been opened for 27 years.

1.3 Pertinent Data.

a. Drainage Area. 3.29 square miles

b. Discharge at Dam Site (cfs).

Maximum known flood at dam site	June 1972, flow unknown
12" water supply line	Unknown
30" drainline	Unknown
Spillway capacity with present configuration (with flashboards)	659
Spillway capacity without flashboards	2,957

c. Elevation (U.S.G.S. Datum) (feet). - All field survey elevations based on spillway crest shown on construction drawings.

Top of dam - field survey	1235.0
Design top of dam	1235.0
Maximum pool - design surcharge	Unknown
Full flood control pool	N/A
Normal pool	1231.0
Spillway crest	1231.0
Upstream portal - bottom intake on 12" water supply line	1201.0
Downstream portal - 12" water supply line	1201.0
Upstream portal - 30" drainline	1200.75
Downstream portal - 30" drainline	1200.75
Streambed at centerline of dam	1184.0
Maximum tailwater	Unknown

d. Reservoir (feet).

Length of maximum pool	800
Length of normal pool	800
Length of flood control pool	N/A

e. Storage (acre-feet).

Normal pool	153
Flood control pool	N/A
Top of dam	211

f. Reservoir Surface (acres).

Top of dam	13
Maximum pool	13
Flood control pool	N/A
Normal pool	10
Spillway crest	10

g. Dam.

Type	Concrete buttress (Ambursen)
Length	303.5 feet
Height (structural height)	51 feet
Top width	0 feet

Side slopes - Upstream	1H:1V
Downstream	Vertical
Zoning	None
Impervious core	None
Cutoff	Core trench to rock
Grout curtain	Yes

h. Reservoir Drain.

Type	30" CIP
Length	44 feet
Closure	Valve between buttresses 5 and 6
Access	Downstream between buttresses 5 and 6
Regulating facilities	Gate valve

i. Spillway.

Type	Uncontrolled over center of dam
Length	193.5 feet (without flashboards)
Crest elevation	1231.0
Gates	Flashboards
Upstream channel	Lake
Downstream channel	None
Weir shape	Sharp crested weir

SECTION 2
ENGINEERING DATA

2.1 Design. Review of information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER) and the Borough of Mount Union show that extensive data is available for review of the structure's original design. Information available consists of construction drawings, correspondence, permits, inspection reports, photographs, and test results. The construction drawings show provisions to raise the dam approximately 15 feet; however, this raising of the dam was never completed.

2.2 Construction. Considerable construction data is available in the PennDER files. Daily construction reports document progress of the construction. The construction inspector made as-built drawings of the buttresses and all completed work. In addition, photographs were taken at all critical areas. Test results of construction materials are available for review.

2.3 Operation. There are no formal operating records.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Bureau of Dam Safety, Obstructions and Storm Water Management, Department of Environmental Resources, Commonwealth of Pennsylvania. The owner made available the borough manager and the water foreman to answer questions regarding operation and construction of the dam.

b. Adequacy. The type and amount of data available is adequate to complete a Phase I Report.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of the Lake Mount Union Dam was conducted by personnel of L. Robert Kimball & Associates accompanied by Borough of Mount Union Water Department Staff, personnel from the Baltimore District U.S. Army Corps of Engineers and personnel from the Washington, D.C. Sewer and Sanitary Authority on April 16, 1979. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works, and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. Visual inspection of the dam indicated the structure was in good condition. In general, the concrete in the dam appeared to be in good condition. Excess waste material from the foundation excavation has been placed beyond the toe of the dam. This waste material has trapped water between the waste material and the upstream slab of the dam. Detailed examination of the structure follows:

1. Between buttresses 1 and 2 a small wet area was noted at the edge of buttress 2. No water was flowing from any of the relief pipes. Some silica buildup has developed on the concrete slab. Some seepage was noted in the abutment rock in front of buttress 1.

2. Between buttresses 2 and 3, there is some silica buildup on the side of buttress 2. On the concrete slab there is a wet area on the left side and on the right side at the junction of the slab and buttress 3. The concrete slab also shows a small area of spalling. At the junction of the slab and buttress 3, there is a small hole in the concrete.

3. Between buttresses 3 and 4, water is ponded at the foundation. In the concrete slab, there is some seepage through the top horizontal joint. There is some silica buildup in the lower portions of the slab.

4. Between buttresses number 4 and 5, water is ponded due to spillway overflow. Water supply lines are housed in this section. In the lower portions of buttress 4 some honeycombing of the concrete was noted. The aggregate is exposed and slight

hammering indicated little or no cement in the concrete. In addition, the steel was exposed during hammering. No appreciable rust was noted on the reinforcing. Buttress 5 showed similar signs of poor concrete on the downstream vertical face. Several portions of buttress 5 also have exposed reinforcing.

5. Between buttresses 5 and 6, the 30" drainline is housed.

6. Between buttresses 6 and 7, the concrete slab has a small deteriorated spot approximately 2 to 3 feet long. In addition, spalling of the concrete slab above the first joint was noted. Buttress 6 shows some concrete deterioration with 1 to 2 feet of steel reinforcing exposed.

7. A large amount of water was flowing over the dam between buttresses 7 and 8. This area was unobservable. Buttress 7 did show a notch in the concrete with bare steel exposed. Buttress 8 showed similar erosion of the concrete.

8. Between buttresses 9 and 10 some seepage was noted at the lower joint of the concrete slab. Buttress 9 showed some concrete deterioration with steel reinforcing exposed. Most of the bays between buttresses 5 and 16 were wet due to flow over the top of the dam or through the flashboards. Some honeycombing of the concrete slab between buttresses 9 and 10 below the top joint was noted. Buttress 10 on the left side showed a hole in the concrete just above the key cut and a crack that extends to the front of the buttress. This hole appears to extend through to the right side of the buttress.

9. Buttress 11 on the left side shows a small 6" hole with steel exposed.

10. Buttress 12 showed deterioration of the concrete below the haunch on the downstream face. Some steel is exposed.

11. Buttress 13 showed minor deterioration of the concrete with some silica buildup on the inside of buttress number 12.

12. No serious problems were noted between buttresses 14, 15 and 16. Some seepage was noted at the left abutment, at the abutment water level, through the abutment rock.

c. Appurtenant Structures. The spillway is located between buttresses 5 and 16 in the center portion of the dam. Between buttresses 6 and 16, the concrete sill is at elevation 1231.0. Between buttress 5 and 6, the spillway is at elevation 1232.0. Wooden flashboards with pipe sockets were placed over the spillway to raise the water level in the reservoir. A low point in the flashboards was made between buttresses 6 and 8 to confine the flow over this area. During tropical storm Agnes in June, 1972, several of the flashboards failed. Between buttresses 7 and 8, the flashboards were completely removed. The flashboards were severely bent in the area between buttresses 6 and 7 and 8 and 9.

The remainder of all the other flashboards have bent. The valve on the middle intake of the 12" supply line has reportedly been broken. The bottom intake reportedly is silted. The 30" drainline has not been operated in the last 27 years. None of the valves were exercised during the inspection. Most of the two lines, the 12" supply line and the 30" drainline, were below water level and were unobserved during the inspection.

d. Reservoir Area. The watershed is predominantly covered with steep woodland. Reservoir slopes are moderately steep, but are not considered susceptible to massive landsliding.

e. Downstream Channel. The downstream channel of Singers Gap Run is very narrow and confined for the first three quarters of a mile below the dam. The channel becomes moderately wide below this point where there are several houses located very close to the stream. Approximately ten houses and one church are located very close to the stream within three miles of the dam.

3.2 Evaluation. The visual inspection did not reveal any immediate signs of instability. The dam appears to be in good condition. The spillway flashboards, the 12" water supply line and the 30" drainline appear to be in rather poor condition.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The reservoir is maintained at as high a level as possible (spillway crest - with flashboards in place). No operation is conducted on the water supply intakes or the drainline.

4.2 Maintenance of the Dam. No planned maintenance schedule is utilized. Maintenance of the dam is considered fair.

4.3 Maintenance of Operating Facilities. Maintenance of the operating facilities is severly lacking. Maintenance of the operating facilities is considered poor.

4.4 Warning System in Effect. There is no warning system in effect.

4.5 Evaluation. Maintenance of the dam is considered fair. Maintenance of the operating facilities is considered poor. There is no warning system in effect to warn downstream residences of large spillway discharges or failure of the dam. The dam is not accessible during periods of flooding.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No calculations or design data pertaining to hydrology were available.

b. Experience Data. No rainfall, runoff or reservoir level data exists. During June 1972, the flashboards partially failed and have not been repaired.

c. Visual Obervations. The concrete in the spillway area appeared to be good condition. All the flashboards have bent or have partially failed. Discharge through the spillway is currently confined to where the flashboards have failed between buttresses 7 and 8.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. The water level in the reservoir prior to flood was at the spillway crest elevation 1231.0.

2. Overtopping potential of the dam was analyzed for the existing conditions (flashboards in place under current configuration) and with no flashboards in the spillway.

3. Dam breach analysis was analyzed for two conditions (maximum water level at 1237.0); (1) flashboards failing and (2) with the flashboards and two sections (32 feet) of the dam failing.

5.3 Summary of Overtopping Analysis. Complete summary sheets from the computer output are presented in Appendix D.

Peak inflow	10,416 cfs
Spillway capacity (present configuration with flashboards in place)	695 cfs
Spillway capacity without flashboards	2,957 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) for this dam is the PMF. The SDF is based upon hazard and size classification. Based on the following definition provided by the Corps of Engineers, the spillway for this dam is rated seriously inadequate as a result of our hydrologic analysis.

> Seriously Inadequate - High hazard classification dams not capable of passing 50% of the PMF without failure when there is a significant increase in the hazard potential for loss of life downstream due to overtopping failure.

The spillway and reservoir are capable of controlling approximately 8% of the PMF with its present configuration with the flashboards. With the flashboards removed, the spillway may be inadequate and not seriously inadequate.

5.4 Summary of Dam Breach Analysis. As the subject dam cannot satisfactorily pass 50% of the PMF (based on our analysis) it was necessary to perform a dam breach analysis and downstream routing of the flood wave. This analysis determines the degree of increased flooding due to dam failure.

Results of the Dam Breach Analysis indicate that downstream flooding is significantly increased. With the flashboards failing the flooding downstream of the dam is not significantly increased (0.5 feet increase in water level with an increase of 1003 cfs). When the flashboards fail and two sections (each section 18 feet wide) failing, flooding downstream is significantly increased. Flood level was analyzed between 0.8 and 2.0 miles downstream of the dam. The flood level increase ranged from 2.9 feet to 3.8 feet with the flow increase ranging from 785 cfs to 8715 cfs. These results indicate that failure due to overtopping will significantly increase downstream potential for loss of life. Detailed results of the flood wave routing are included in Appendix D.

Note: Future development within the watershed, at the dam, or downstream may change the characteristics and assumptions made for this study and different results are likely. Future development downstream may also greatly increase the potential for loss of life due to failure of the structure.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual inspection did not reveal any signs of immediate instability. The dam appears to be well constructed and conforms to the construction drawings.

b. Design and Construction Data. No record of design data, stability analysis or stress analysis for the original structure was available for review.

c. Operating Records. There are no operating records.

d. Post-Construction Changes. There have been no post-construction changes.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analysis has been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading.

f. Check of Stability Analysis. An approximate check of the stability of the dam was performed. The assumptions were as follows:

1. Cross section through the spillway.

2. Cross section used as shown on the construction drawings.

3. Effect of key neglected. Assumed horizontal foundation surface.

4. Water level at 1239.5 (PMF).

5. Tailwater pressure and silt loads neglected.

Using the above assumptions the stability analysis indicated a safety factor of 2.0 against overturning and a sliding factor of 0.75. This indicates that the dam is probably stable during the PMF with the conditions analyzed. It is believed that the flashboards will fail before the water level in the reservoir reaches 1239.5.

Because of the nature of this type of dam, a stress analysis is more pertinent than a stability analysis from overturning. Because of the many different sections in this type of dam and the many assumed conditions, it is recommended that a more detailed structural analysis (including a stress analysis) be conducted.

SECTION 7

ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The dam appears to be in good condition. The visual observations, review of available information, hydrologic calculations, and past operational performance indicate that Lake Mount Union Dam's spillway is seriously inadequate. The spillway in its present configuration is capable of controlling approximately 8% of the PMF without overtopping the dam. As a result of the seriously inadequate spillway, the dam is considered to be an unsafe non-emergency dam. No stability analysis has been performed. An approximate stability analysis for the structure was conducted and the dam appears to be stable with the assumptions made for this study.

b. Adequacy of Information. The information available appears to be adequate to complete a Phase I report.

c. Urgency. The recommendations suggested below should be implemented immediately.

d. Necessity for Further Investigation. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. Perform additional studies by a registered professional engineer knowledgeable in dam design for modifications of the spillway and/or dam to increase spillway capacity. This study should begin immediately and remedial modifications begun immediately after the study is complete.

2. The flashboards should be immediately removed to increase the spillway capacity until recommendation 1 is completed.

3. A warning system should be instituted to warn downstream residences of high spillway discharges and during periods of heavy rainfall or high runoff, or failure of the dam.

4. Access to the dam should be improved so the dam is accessible during periods of flooding.

5. Institute a formal inspection program to be conducted at regular intervals.

6. Repair drain lines to a workable condition. Exercise all gates on the drain line and the supply line at regular intervals.

7. Perform a detailed structural analysis (including a stress analysis) using the PMF water level for all probable conditions and major sections of the dam.

APPENDIX A

CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Lake Mount Union Dam COUNTY Huntingdon STATE Pennsylvania ID# PA 473

TYPE OF DAM Concrete buttress (Ambursen) HAZARD CATEGORY High

DATE(s) INSPECTION April 16, 1979 WEATHER Cloudy TEMPERATURE 50°F

POOL ELEVATION AT TIME OF INSPECTION 1231.1 M.S.L. TAILWATER AT TIME OF INSPECTION None M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, L. Robert Kimball & Associates

James T. Hockensmith, L. Robert Kimball & Associates

Kuang-hwei Chuang, L. Robert Kimball & Associates

John Pierchoski, L. Robert Kimball & Associates

Howard Kass, Baltimore District Corps of Engineers

Boyd Runk, Water Foreman, Borough of Mount Union

James T. Hockensmith RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	N/A	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	N/A	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	N/A	
RIPRAP FAILURES	N/A	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	N/A	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	N/A	
ANY NOTICEABLE SEEPAGE	N/A	
STAFF GAUGE AND RECORDER	N/A	
DRAINS	N/A	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Minor amounts of seepage noted in construction drawings on concrete slab.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Both abutments appear to be good.	
DRAINS	None.	
WATER PASSAGES	None.	
FOUNDATION	Unobserved. Shale and quartzite.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	One minor crack in buttress 10. Concrete in general appears to be good. There has been some silica buildup in certain areas. Minor amount of concrete deterioration on buttresses. In several areas, the reinforcing steel on the buttresses is exposed. Some honeycombing of the concrete in several areas.	
STRUCTURAL CRACKING	None noted.	
VERTICAL AND HORIZONTAL ALIGNMENT	Both appear to be good.	
MONOLITH JOINTS	Good.	
CONSTRUCTION JOINTS	Good.	
STAFF GAUGE OR RECORDER	None.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The 12" cast iron pipe - unobserved. Three intakes at different elevations with 16" cast iron pipes. Water is currently drawn off the top intake. The valve on the center intake reportedly is broken. The bottom intake is reportedly silted shut.	
INTAKE STRUCTURE	Three intakes on concrete slab on upstream face of dam. The intakes have screens. Unobserved.	
OUTLET STRUCTURE	No outlet structure. The 12" pipe runs directly to the borough.	
OUTLET CHANNEL	None.	
EMERGENCY GATE	30" cast iron blow-off line located between buttresses 6 and 7. Condition unobserved - below water level.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Appears to be good. Concrete weir has 4' high wooden flashboards, many of which are bent and some are missing.	
APPROACH CHANNEL	Lake.	
DISCHARGE CHANNEL	None.	
BRIDGE AND PIERS	None.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

DOWNSTREAM CHANNEL

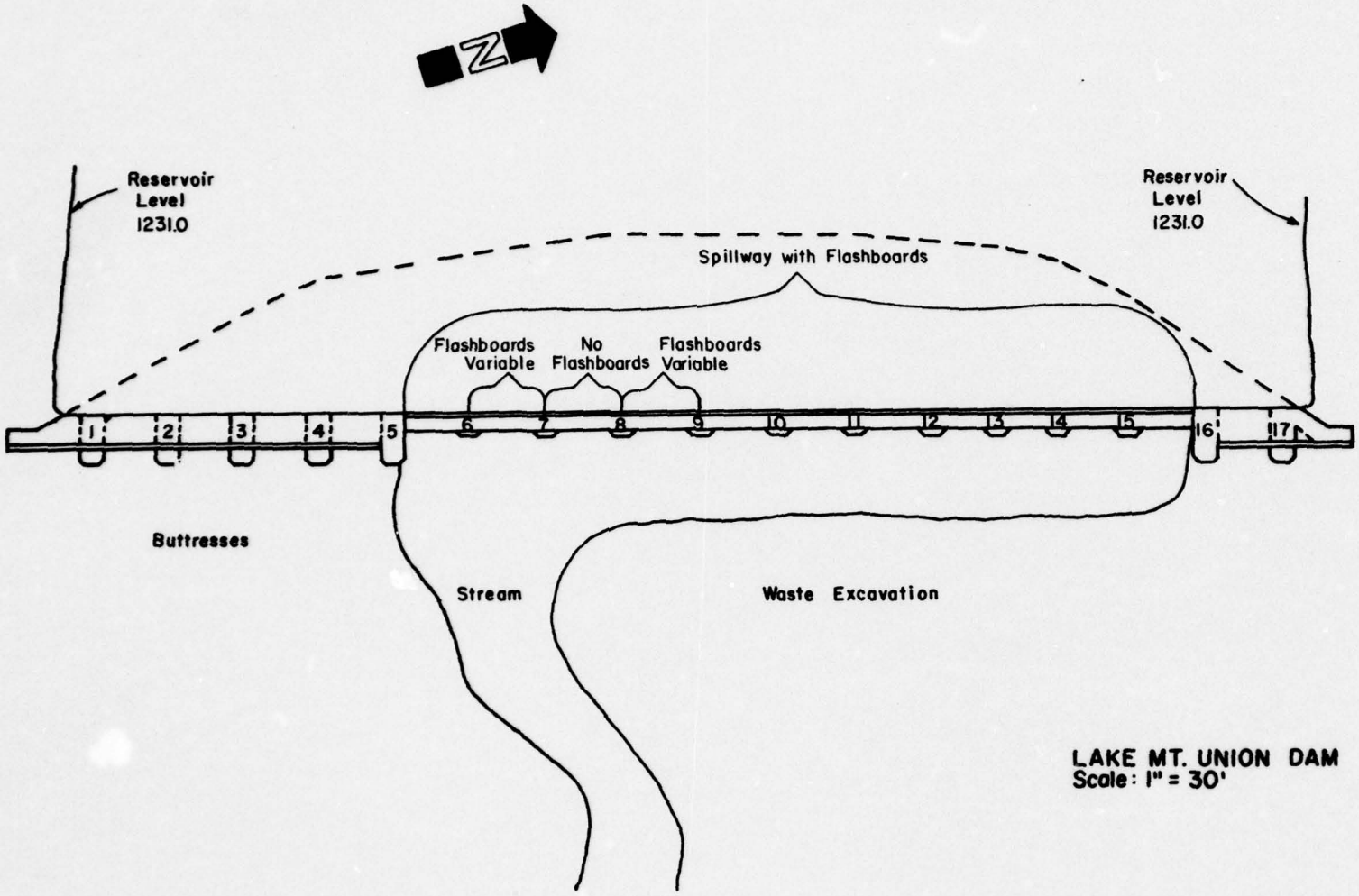
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Very narrow and confined for the first three quarters of a mile. No homes located within this stretch.	
SLOPES	Steep to moderate.	
APPROXIMATE NO. OF HOMES AND POPULATION	Within three miles, approximately 10 homes and 1 church (approximately 40+ people).	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderately steep.	
SEDIMENTATION	Considerable. Bottom intake on water supply line silted shut.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	



LAKE MT. UNION DAM
Scale: 1" = 30'

DIX B

CHECKLIST, ENGINEER[illegible]A, DESIGN, CONSTRUCTION, OPERATION, PHASE I

APPENDIX B

CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Lake Mount Union Dam

ID# PA 473

ITEM	REMARKS
AS-BUILT DRAWINGS	None available.
REGIONAL VICINITY MAP	U.S.G.S quadrangle.
CONSTRUCTION HISTORY	PennDER files, considerable.
TYPICAL SECTIONS OF DAM	Construction drawings.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS	Construction drawings. Construction drawings. None. None. None.

ITEM	REMARKS
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None. None. PennDER files. PennDER files.
POST-CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	Unknown.

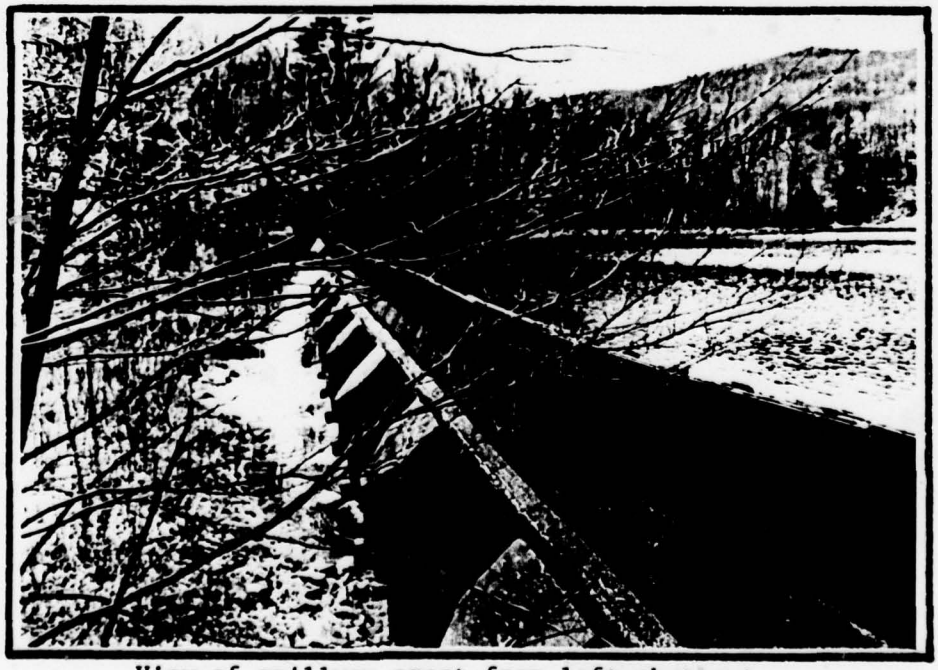
ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Construction drawings.
OPERATING EQUIPMENT PLANS & DETAILS	Construction drawings.

APPENDIX C

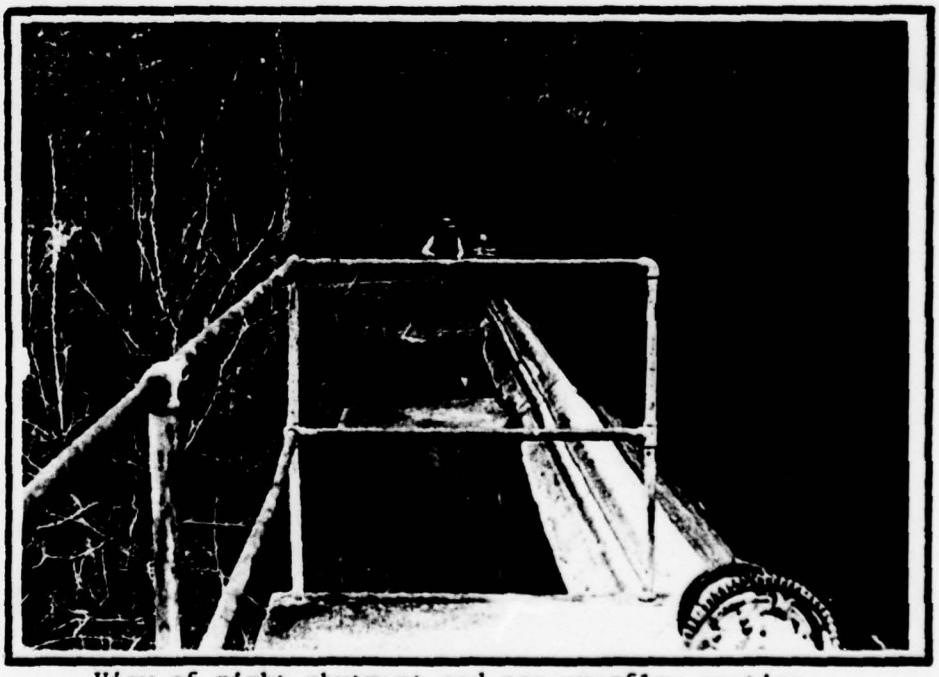
PHOTOGRAPHS

View of spillway crest and flashboards from right abutment.

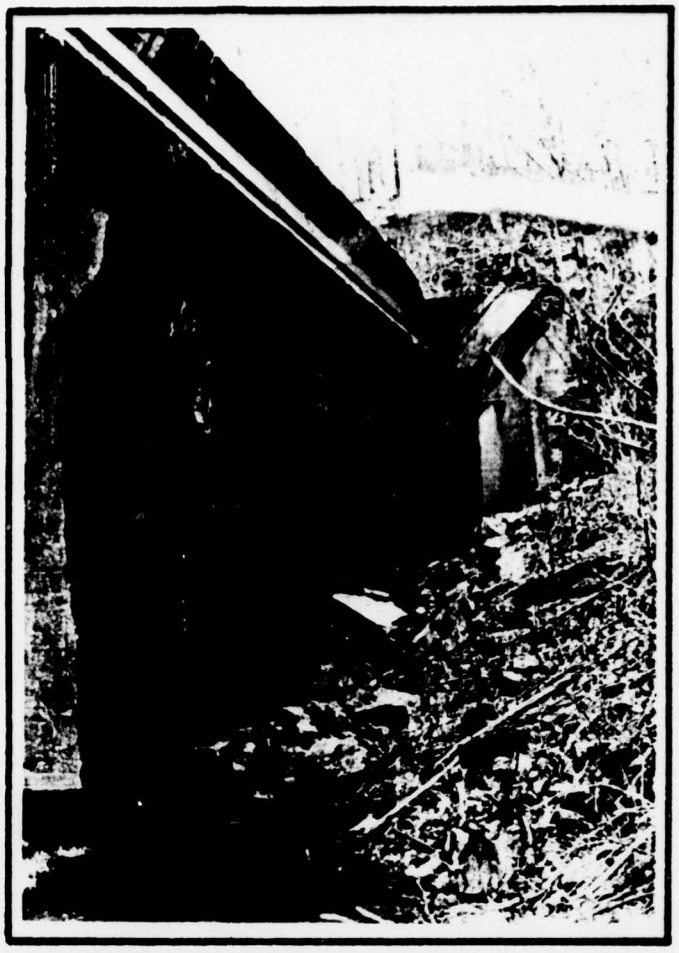


View of spillway crest from left abutment.

Downstream view of buttresses looking toward right abutment.

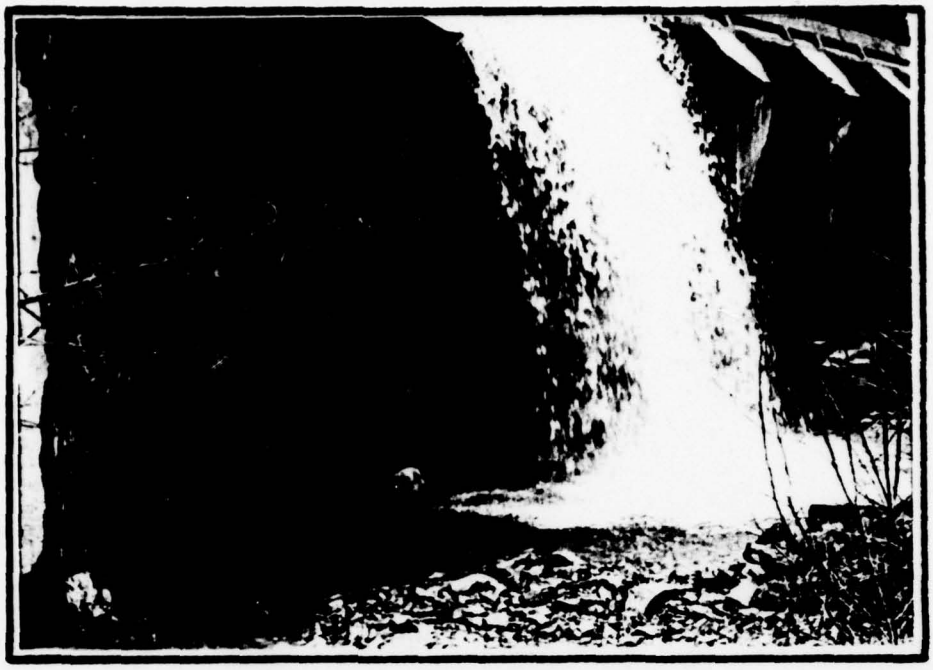


View of right abutment and non-overflow section.



Downstream view of buttress looking toward left abutment. Note: waste rock downstream of buttresses.

Left abutment. Note: grout pipes.



Water flowing over spillway between buttresses 7 and 8.
Note: deterioration of concrete buttresses.

Immediate downstream exposure.

First downstream residence.

Several homes adjacent to stream.

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Reports No. 40 prepared by the National Weather Service.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
C_t	Coefficient representing variations of watershed slope and storage	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topographic
L_{ca}	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
C_p	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE MOUNT UNION
I.D. NUMBER PA 31-52
SHEET NO. 1 OF 4
BY OTM DATE 5-8-79

LAKE MOUNT UNION

DRAINAGE AREA

AREA = 3.5 SQ. MILES (FROM U.S.G.S. 7.5 MIN. QUAD.)

UNIT HYDROGRAPH PARAMETERS

DAMSITE LOCATED IN ZONE #21, SUSQUEHANNA RIVER BASIN. FROM CORPS OF ENGINEERS, BALTIMORE DISTRICT REGIONAL STUDY.

$C_p = 0.55$ $C_t = 1.50$ (FROM C.O.E. BALTIMORE DIST.)

$L = 2.2$ MILES, $L_{ca} = 0.3$ MILES (FROM U.S.G.S 7.5 MIN. QUAD.)

$t_p = C_t (L \times L_{ca})^{0.3} = 1.5 (2.2 \times 0.34)^{0.3}$

$t_p = 1.50 (0.92) = 1.37$ HRS. (SNYDERS LAG (t_p) IN HOURS)

LOSS RATE AND BASE FLOW PARAMETERS

AS RECOMMENDED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT.

STRTL = 1 INCH
CNSTL = 0.05 IN/HR
STRTQ = 1.5 cfs/mi^2
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.00

PROBABLE MAXIMUM STORM

FROM H.R. 40
PMP, INDEX RAINFALL $22.2(1.04) = 23.1$ IN.

$R_6 = 117\%$, $R_{12} = 127\%$, $R_{24} = 136\%$, $R_{48} = 143\%$, $R_{72} = 145\%$

ELEVATION - AREA - CAPACITY - RELATIONSHIPS

FROM U.S.G.S. 7.5 MIN. QUAD., D.E.R. FILES AND FIELD INSPECTION DATA.

AT SPILLWAY CREST, ELEV. 1231.0'
AREA = 10 ACRES
INITIAL STORAGE = 153 AC. FT.

AT 1240', AREA = 16 ACRES
AT 1260', AREA = 25 ACRES

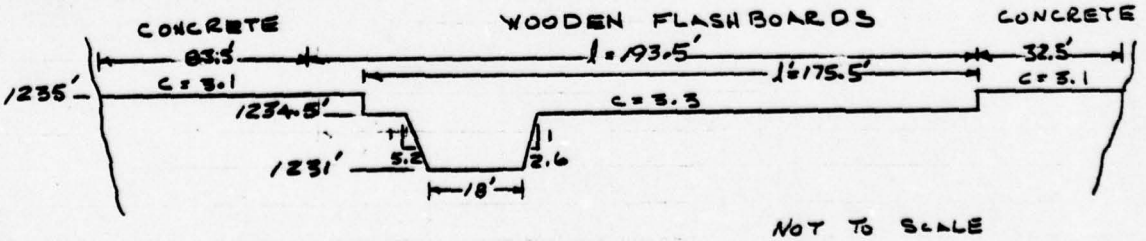
FROM CONIC METHOD FOR RESERVOIR VOLUME. FLOOD HYDROGRAPH PACKAGE (HEC-1). DAM SAFETY VERSION (USERS MANUAL).

$H = 3V/A = 3(153)/10 = 45.9'$
ELEV. AT CAPACITY EQUALS ZERO;
1231' - 46' = 1185'

ELEV. (FT.)	1185	1231	1235	1240	1245	1250	1255	1260
AREA (AC.)	0	10	13	16	18	21	23	25

DISCHARGE RATING CURVES

TWO DISCHARGE CURVES WERE CALCULATED FOR TWO CONDITIONS. CONDITION NUMBER ONE - ACTUAL CONDITION. CONDITION NUMBER TWO - ALL FLASHBOARDS REMOVED.



NOT TO SCALE

TOP OF DAM AT ELEV. 1235'

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE MOUNT UNION
I.D. NUMBER PA. 31-52
SHEET NO. 3 OF 4
BY OTM DATE

CONDITION NO. 1

ELEV. (FT.)	TRAPEZOIDAL FLOW hp (FT.)	TRAPEZOIDAL FLOW Q (cfs)	RECTANGULAR FLOW h (FT.)	RECTANGULAR FLOW Q (cfs)	Q TOTAL (cfs)
1231.0	0	0			0
1231.5	0.5	20			20
1232.0	1	61			61
1232.5	1.5	118			118
1233.0	2	194			194
1233.5	2.5	287			287
1234.0	3	398			398
1234.5	3.5	528			528
1235.0			0.5	152	680
1236.0			1	639	1320
1237.0			2	1806	2490
1238.0			3	3318	4000
1239.0			4	5108	5790
1240.0			5	7139	7820
1241.0			6	9384	10060
1242.0			7	11826	12500
	$C' = 0.95$		$C = 3.3$, $l' = 175.5'$, $l = 193.5'$		

CONDITION NO. 2 (FLASH BOARDS REMOVED)

DISCHARGE CURVE DETERMINED WITH HEC-1.

LENGTH OF SPILLWAY = 193.5'
C = 3.3
SPILLWAY CREST AT ELEV. 1231'

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE MOUNT UNION
I.D. NUMBER PA 31-52
SHEET NO. 4 OF 4
BY OTM DATE 5-14-79

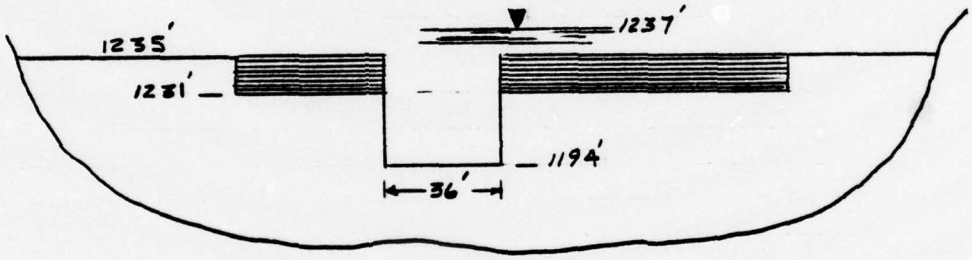
OVERTOP PARAMETERS

ELEV. TOP OF DAM = 1235'
LENGTH OF DAM = 116'
COEFFICIENT = 3.1 BROAD CREST WEIR

DISCHARGE CURVE WAS DETERMINED WITH (HEC-1).

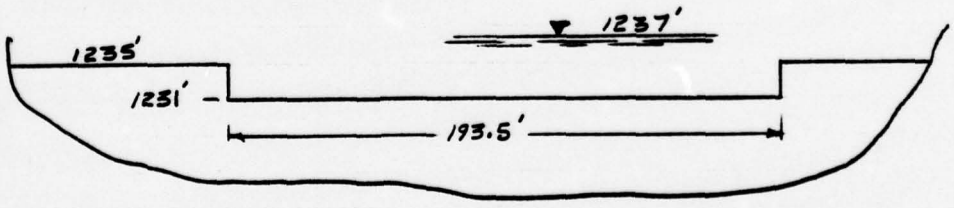
DAM BREACH PARAMETERS

PLAN 1 (SECTION OF FLASHBOARDS AND STRUCTURE FAIL)



RATIO OF PMF = 0.4
BREACH WIDTH = 36'
SIDE SLOPE OF BREACH = 0
FAILURE TIME = 0.25 HRS.
ELEVATION
FAILURE BEGINS = 1237'

PLAN 2 (FLASHBOARDS FAIL)



RATIO OF PMF = 0.4
BREACH WIDTH = 193.5'
SIDE SLOPE OF BREACH = 0
FAILURE TIME = 0.25 HRS.
ELEVATION
FAILURE BEGINS = 1237'

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 3.29 square miles, steep wooded

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1231.0 (164 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1235.0

SPILLWAY CREST:

a. Elevation 1231.0
b. Type Sharp crested weir with wooden flashboards
c. Width
d. Length 193.5 feet
e. Location Spillover Center of dam
f. Number and Type of Gates Flashboards

OUTLET WORKS:

a. Type 12" cast iron pipe
b. Location Between buttress 4 and 5
c. Entrance inverts 1201.0
d. Exit inverts 1201.0
e. Emergency draindown facilities 30" cast iron pipe

HYDROMETEOROLOGICAL GAUGES:

a. Type NONE
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: June 1972, flow unknown, dam undamaged however, flashboards were damaged.

```
*************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION        JULY 1978
  LAST MODIFICATION   26 FEB 79
*************************************
      1          A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
      2          A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF LAKE MOUNT UNION DAM  PA 31-52
      3          A3      RATIOS OF PMF ROUTED THROUGH THE RESERVOIR
      4          B     288       0      15       0       0       0       0       0  [illegible]     0
      5          B1      5
      6          J       1       6       1
      7          J1     .1      .2      .3      .4      .5       1
      8          K               1
      9          K1      INFLOW TO RESERVOIR
     10          M       1       1  [illegible]       [illegible]
     11          P            23.1     117     127     136     143     145
     12          T                                                     1.0    0.05
     13          W    1.37    0.55
     14          X  [illegible]  -.05  2.0
     15          K       1       2
     16          K1      ROUTE THROUGH RESERVOIR
     17          Y                               1       1
     18          Y1      1                                        -1231      -1
     19          Y4   1231  1231.5    1232  1232.5    1233  1233.5    1234  1234.5    1235    1236
     20          Y4   1237    1238    1239    1240    1241    1242
     21          Y5      0      20      61     118     194     281     398  [illegible]  [illegible]  1020
     22          Y5   2490    4000    5790    7820   10060   12500
     23          SA      0      10      13      16      18      21      23      25
     24          SE   1185    1231    1235    1240    1245    1250    1255    1260
     25          SS   1231
     26          SD   1235     3.1     1.5     116
     27          K      99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE 79/09/10.
TIME 16.11.53.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF LAKE MOUNT UNION DAM, PA 31-88
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS= .10, .20, .30, .50, .75, 1.00,

****

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.20	0.00	3.30	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.10	117.00	127.00	138.00	183.00	183.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.17 CP= .33 MSK= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES LAG= 2.34 HOURS, CP= .33 VOL= 1.00

591.	816.	630.	646.	501.	395.	291.	211.	153.	111.
426.	365.	312.	267.	228.	195.	167.	143.	122.	105.
89.	77.	66.	56.	48.	41.	35.	30.	26.	22.
19.	16.	14.	12.	10.	9.	7.	6.		

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.80	24.16	2.64	208936.
										681.11	613.11	67.11	5916.611

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

CLOSS	CLOSS	AVG	IRES	ISAME	IOP	IPMP	LSTR
0.0	0.000	0.00	1	1		0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1231.	-1

STAGE	1231.00	1231.50	1232.00	1232.50	1233.00	1233.50	1234.00	1234.50	1235.00
1236.00									
	1237.00	1238.00	1239.00	1240.00	1241.00	1242.00			
FLOW	0.00	20.00	61.00	118.00	194.00	287.00	398.00	528.00	680.00
1320.00									
	2500.00	4000.00	5700.00	7620.00	10000.00	12500.00			
SURFACE AREA=	0.	10.	13.	16.	18.	21.	23.	25.	
CAPACITY=	0.	153.	199.	272.	357.	454.	564.	684.	
ELEVATION=	1231.	1231.	1232.	1233.	1234.	1235.	1236.	1237.	

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1231.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1238.0	3.1	1.5	1000.

PEAK OUTFLOW IS 999. AT TIME 41.25 HOURS

PEAK OUTFLOW IS 2011. AT TIME 41.00 HOURS

PEAK OUTFLOW IS 3019. AT TIME 41.00 HOURS

PEAK OUTFLOW IS 4039. AT TIME 41.00 HOURS

PEAK OUTFLOW IS 5046. AT TIME 41.00 HOURS

PEAK OUTFLOW IS 10108. AT TIME 41.00 HOURS

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS					
				RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 1.00
HYDROGRAPH AT	1	3.30 (8.55)	1	101. (2.86)	202. (5.72)	304. (8.61)	405. (11.47)	507. (14.36)	1015. (28.74)
ROUTED TO	2	3.30 (8.55)	1	999. (28.29)	2011. (56.94)	3019. (85.50)	4035. (114.25)	5046. (142.881)	10105. (286.15)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	1231.00	1231.00	1235.00
STORAGE	153.	153.	199.
OUTFLOW	0.	[illegible]	[illegible]

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME O FAILURE HOURS
.10	1235.27	.27	[illegible]	[illegible]	[illegible]	[illegible]	0.00
.20	1236.19	1.19	[illegible]	[illegible]	[illegible]	[illegible]	0.00
.30	1236.74	1.74	223.	3019.	6.75	41.00	0.00
.40	1237.23	2.23	230.	4035.	7.50	41.00	0.00
.50	1237.66	2.66	236.	5046.	8.25	41.00	0.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
     1          A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
     2          A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF LAKE MOUNT UNION DAM - PA 31-53
     3          A3      RATIOS OF PMF ROUTED THROUGH THE RESERVOIR...NO FLASHBOARDS...
     4          B    288          0      15       0       0       0       0       0      60       0
     5          B1     5
     6          J      1       3       1
     7          J1    .5      .6      1
     8          K              1                                                       1
     9          K1     INFLOW TO RESERVOIR
    10          M      1       1     383     383
    11          P                   23.1     117     127     136     143     145
    12          T                                                           1.0     0.05
    13          W     1.37    0.25
    14          X    -1.5    -.05     2.0
    15          K      1       2                                                       1
    16          K1     ROUTE THROUGH RESERVOIR
    17          Y                                           1       1
    18          Y1     1                                                    -1231
    19          YA     0      10      13      16      18      21      23      25
    20          YS   1185    1231    1235    1240    1245    1250    1255    1260
    21          YR   1281   1934.5     5.3     1.5
    22          YD   1135     2.1     1.9     1.6
    23          K      99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE 79/05/11.
TIME 13.09.16.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF LAKE MOUNT UNION DAM, PA 31-12
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR...NO FLASHBOARDS...

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 3 LRTIO= 1

RTIOS= .50 .60 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.30	0.00	3.30	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.10	117.00	127.00	136.00	145.00	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.97 CP= .59 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 38 END-OF-PERIOD ORDINATES. LAG= [illegible] HOURS, CP= .59 VOL= 1.00

59.	218.	480.	656.	801.	836.	788.	681.	582.	498.
426.	365.	312.	267.	228.	195.	167.	143.	122.	105.
89.	77.	66.	56.	48.	41.	35.	30.	26.	22.
19.	16.	14.	12.	10.	9.	7.	6.		

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.00	24.16	2.64	208936.
										673.11	614.11	67.11	5916.41

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1221.	0

SURFACE AREA=	0.	10.	133	16.	18.	21.	23.	29.
CAPACITY=	0.	153.	199.	272.	357.	454.	564.	684.
ELEVATION=	1185.	1231.	1235.	1240.	1245.	1250.	1255.	1260.

CREL	SPWID	COOM	EXPW	ELEVL	COOL	CAREA	EXPL
1231.0	193.8	3.3	1.9	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1239.0	3.1	1.8	1164.

PEAK OUTFLOW IS 8039. AT TIME 41.00 HOURS

PEAK OUTFLOW IS 6059. AT TIME 41.00 HOURS

PEAK OUTFLOW IS 10114. AT TIME 41.00 HOURS

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS RATIO 1 .50	RATIO 2 .60	RATIO 3 1.00
HYDROGRAPH AT	1	3.30 (8.55)	1	5073. (143.65)	6088. (172.38)	10146. (287.30)
ROUTED TO	2	3.30 (8.55)	1	5039. (142.68)	6059. (171.58)	10114. (286.39)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1231.00	1231.00	1235.00
STORAGE	153.	153.	199.
OUTFLOW	0.	0.	5108.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1234.96	0.00	198.	5017.	0.00	37.00	0.00
.62	1235.43	.43	210.	6859.	1.75	39.00	0.00
1.00	1236.91	1.91	225.	10114.	3.75	41.00	0.00

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
     1          A1       RATIO OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
     2          A2       DOWNSTREAM CONDITION DUE TO OVERTOP  LAKE MOUNT UNION  PA 31-52
     3          A3       PLANS 1 AND 2 ASSUME BREACH. PLAN 3 ASSUMES NO BREACH
     4          B    288       0      15       0       0       0       0       0      -4       0
     5          B1     5
     6          J      3       1       1
     7          J1   0.4
     8          K                  1                               1
     9          K1       INFLOW TO RESERVOIR
    10          M      1       1     3.3             3.3                                     1
    11          P.                23.1     117     127     136     143     145
    12          T                                                       1.0    0.05
    13          W    1.37    0.55
    14          X    1.5    -.05     2.0
    15          K      1       2                                       1
    16          K1       ROUTE THROUGH RESERVOIR
    17          Y                                       1       1
    18          Y1     1                                                -1231      -1
    19          Y4   1231  1231.5    1232  1232.5    1233  1233.5    1234  1234.5    1235    1236
    20          Y4   1237    1238    1239    1240    1241    1242
    21          Y5      0      20      61     118     194     287     398     528     680    1320
    22          Y5   2490    4000    5790    7820   10060   12500
    23          $A      0      10      13      16      18      21      23      25
    24          $E   1185    1231    1235    1240    1245    1250    1255    1260
    25          $$   1231
    26          SD   1235     3.1     165     116
    27          $B     36       0    1194    0.25    1231    1237
    28          $B  193.5       0    1231    0.25    1231    1237
    29          $B  193.5       0    1231    0.25    1231    1240
    30          K      1       3                                       1
    31          K1       CHANNEL ROUTING - MUD PULS REACH 2-3
    32          Y                                       1       1
```

```
33              Y1    1
34              Y6  .06    .05    .06   1000   1040   4400  0.0429
35              Y7    0   1040    150   1020    240   1002     245   1000     255   1000
36              Y7  260   1002    450   1020    600   1040
37              K     1      4                                   1
38              K1        CHANNEL ROUTING - MOD PULS REACH 3-4
39              Y                                 1      1
40              Y1    1
41              Y6  .06    .05    .06    896    920   2500  0.0400
42              Y7    0    920     75    900    115    898     120    896     130    896
43              Y7  135    898    175    900   1065    920
44              K     1      5                                   1
45              K1        CHANNEL ROUTING - MOD PULS REACH 4-5
46              Y                                 1      1
47              Y1    1
48              Y6  .06    .05    .06    780    820   3400  0.0353
49              Y7    0    820    540    800    940    782     945    780     955    780
50              Y7  950    782   1060    800   1070    820
51              E     99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE 79/05/14.
TIME 13.08.53.

RATIO OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
DOWNSTREAM CONDITION DUE TO OVERTOP LAKE MOUNT UNION PA 31-92
PLANS 1 AND 2 ASSUME BREACH. PLAN 3 ASSUMES NO BREACH

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	99	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 3 NRTIO= 1 LRTIO= 1

RTIOS= .40

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.30	0.00	3.30	0.00	0.000	0	1	0

PRECIP DATA

	SPFE	PMS	R6	R12	R24	R48	R72	R96
	0.00	23.10	117.00	127.00	136.00	143.00	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.37 CP= .55 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 38 END-OF-PERIOD ORDINATES, LAG= 1.36 HOURS, CP= .59 VOL= 1.00

59.	216.	430.	646.	801.	856.	795.	681.	582.	498.
426.	365.	312.	267.	228.	195.	167.	143.	122.	105.
89.	77.	66.	56.	48.	41.	35.	30.	26.	22.
19.	16.	14.	12.	10.	9.	7.	6.		

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP P
									SUM	26.80	24.16	2.64	2089364
										(681.)(614.)(67.)(5916.4V)			

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSSR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1231.	-1

STAGE	1231.00	1231.50	1232.00	1232.50	1233.00	1233.50	1234.00	1234.50	1235.00
1236.00									
	1237.00	1238.00	1239.00	1240.00	1241.00	1242.00			
FLOW	0.00	20.00	61.00	118.00	194.00	287.00	398.00	528.00	680.90
1320.00									
	2490.00	4000.00	5790.00	7820.00	10060.00	12500.00			
SURFACE AREA=	0.	10.	13.	16.	18.	21.	23.	25.	
CAPACITY=	0.	153.	199.	272.	357.	454.	564.	684.	
ELEVATION=	1185.	1231.	1235.	1240.	1245.	1250.	1255.	1269.	

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1231.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1235.0	3.1	1.5	116.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
36.	0.00	1194.00	.25	1231.00	1237.00

BEGIN DAM FAILURE AT 40.75 HOURS

PEAK OUTFLOW IS 17202. AT TIME 41.00 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
194.	0.00	1231.00	.25	1231.00	1237.00

BEGIN DAM FAILURE AT 40.75 HOURS

PEAK OUTFLOW IS 5712. AT TIME 40.76 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
194.	0.00	1231.00	.25	1231.00	1240.00

PEAK OUTFLOW IS 4035. AT TIME 41.00 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTING - MOD PULS REACH 2-3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	1000.0	1040.0	4400.	.04290

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1040.00 150.00 1020.00 240.00 1002.00 245.00 1000.00 255.00 1000.00
260.00 1002.00 450.00 1020.00 600.00 1040.00

STORAGE	0.00	3.25	11.33	26.38	48.39	77.37	113.31	156.21	205.98
262.91	326.68	397.19	474.41	558.36	649.01	746.39	850.47	961.28	1978.70
1203.03									
OUTFLOW	0.00	264.98	1278.19	3500.62	7356.22	13210.94	21397.77	32226.55	45989.39
62964.69	83515.58	107931.46	136337.21	168941.05	205952.89	247581.63	294033.87	345513.42	402221.90
464354.25									
STAGE	1000.00	1002.11	1004.21	1006.32	1008.42	1010.53	1012.63	1014.74	1015.84
1018.95	1021.05	1023.16	1025.26	1027.37	1029.47	1031.58	1033.68	1035.79	1036.89
1040.00									

FLOW	0.00	264.98	1278.19	3500.62	7356.22	13210.94	21397.77	32226.55	45989.39
62964.69									
	83515.58	107931.46	136337.21	168941.05	205952.89	247581.63	294033.87	345513.42	402221.90
464354.25									

MAXIMUM STAGE IS 1010.4

MAXIMUM STAGE IS 1007.1

MAXIMUM STAGE IS 1006.6

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTING - MOD PULS REACH 3-4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSSR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL

.0600 .0800 .0600 896.0 920.0 2500. .04000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 920.00 75.00 900.00 115.00 898.00 120.00 896.00 130.00 898.00
138.00 898.00 175.00 900.00 1065.00 920.00

STORAGE	0.00	.95	2.64	7.45	16.18	29.32	46.88	68.86	95.26
126.07									
	161.30	200.96	245.03	293.51	346.42	403.74	465.48	531.65	602.13
677.23									
OUTFLOW	0.00	98.34	388.44	1140.80	2704.83	5454.96	9665.14	15593.95	23483.21
33561.42									
	46045.32	61142.72	79053.44	99970.44	124080.70	151565.86	182602.81	217364.13	256018.37
298730.91									
STAGE	896.00	897.26	898.53	899.79	901.05	902.32	903.58	904.84	906.11
907.37									
	908.63	909.89	911.16	912.42	913.68	914.95	916.21	917.47	918.64
920.00									
FLOW	0.00	98.34	388.44	1140.80	2704.83	5454.96	9665.14	15593.95	23483.21
33561.42									
	46045.32	61142.72	79053.44	99970.44	124080.70	151565.86	182602.81	217364.13	256017.36
298730.91									

MAXIMUM STAGE IS 904.1

MAXIMUM STAGE IS 902.1

MAXIMUM STAGE IS 901.7

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTING - MOD PULS REACH 4-5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0900	.0600	780.0	820.0	3400.	.03830

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 820.00 540.00 800.00 940.00 782.00 948.00 780.00 955.00 780.00
960.00 782.00 1060.00 800.00 1070.00 820.00

STORAGE	0.00	2.52	11.09	29.27	57.06	94.46	141.47	198.09	264.22
340.16									
	425.59	520.55	625.03	739.02	862.52	995.53	1138.06	1290.10	1451.56
1622.73									
OUTFLOW	0.00	240.41	1308.67	4063.93	9236.04	17443.70	29244.59	45154.67	65658.56

91216.56

122240.24 159229.47 202592.31 252674.06 309819.58 374370.86 446665.94 527038.40 615817.V2

713326.32

STAGE	780.00	782.11	784.21	786.32	788.42	790.53	792.63	794.74	796.79
798.95									
	801.05	803.16	805.26	807.37	809.47	811.58	813.68	815.79	816.79
820.00									
FLOW	0.00	240.41	1308.67	4063.93	9236.04	17443.70	29244.59	45154.67	65658.56
91216.56									
	122240.24	159229.47	202592.31	252674.06	309819.58	374370.86	446665.94	527038.40	615817.12
713326.32									

MAXIMUM STAGE IS 789.2

MAXIMUM STAGE IS 786.7

MAXIMUM STAGE IS 788.8

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUSATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .40
HYDROGRAPH AT	1	3.30 (8.55)	1	4058. (114.92)(
			2	4058. (114.92)(
			3	4058. (114.92)(
ROUTED TO	2	3.30 (8.55)	1	17202. (487.10)(
			2	5616. (159.03)(
			3	4035. (114.25)(
ROUTED TO	3	3.30 (8.55)	1	12738. (360.71)(
			2	5026. (142.31)(
			3	4029. (113.91)(
ROUTED TO	4	3.30 (8.55)	1	11883. (336.48)(
			2	4991.

			(141.34)(
		3	4033.
			(114.21)(
ROUTED TO	8	3.30	1 12136.
	(	8.55)	(343.66)(
			2 4987.
			(141.23)(
		3	4024.
			(113.94)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1231.00	1231.00	1235.00
STORAGE	153.	153.	199.
OUTFLOW	0.	0.	680.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	1237.13	2.13	228.	17202.	3.11	41.00	40.75

PLAN 2 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1231.00	1231.00	1235.00
STORAGE	153.	153.	199.
OUTFLOW	0.	0.	680.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	1237.14	2.14	228.	5712.	3.25	40.76	40.75

PLAN 3 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1231.00	1231.00	1235.00
STORAGE	153.	153.	199.
OUTFLOW	0.	0.	680.

RATIO OF	MAXIMUM RESERVOIR	MAXIMUM DEPTH	MAXIMUM STORAGE	MAXIMUM OUTFLOW	DURATION OVER TOP	TIME OF MAX OUTFLOW	TIME OF FAILURE

PMF	W.S.ELEV	OVER DAM	AC-FT	CFS	HOURS	HOURS	HOURS
.40	1237.23	2.23	230.	4035.	7.50	41.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	12738.	1010.46	41.00

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	5026.	1007.1	41.00

PLAN 3 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	4023.	1006.6	41.25

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	11883.	904.1	41.25

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	4991.	902.1	41.25

PLAN 3 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	4023.	901.7	41.25

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	12136.	789.2	41.25

PLAN 2 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	4987.	786.7	41.25

PLAN 3 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	4024.	786.2	41.25

APPENDIX E

DRAWINGS

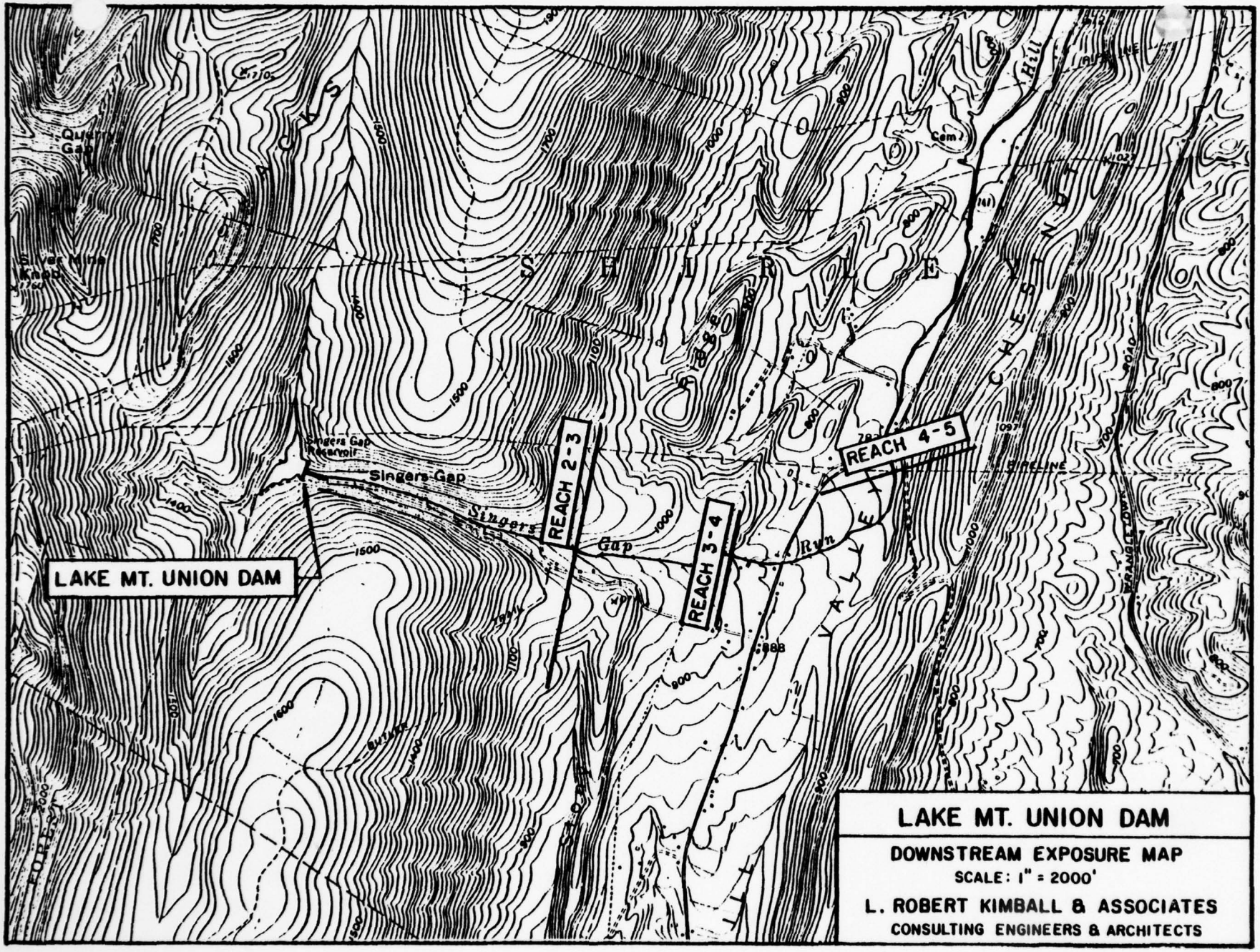
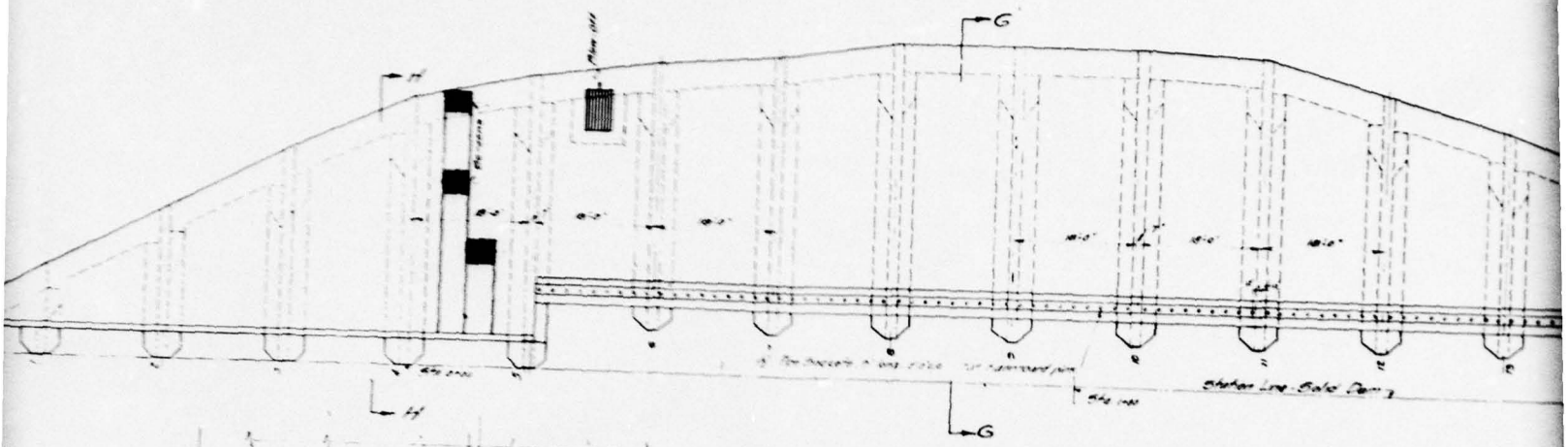
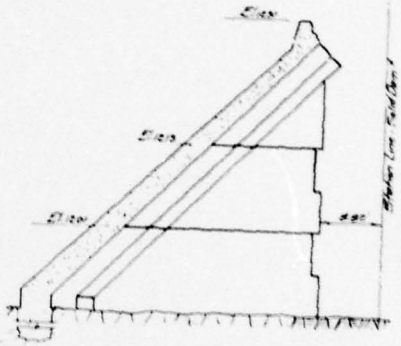

LAKE MT. UNION DAM
REACH 2-3
REACH 3-4
REACH 4-5
Singers Gap Reservoir
Singers Gap
Singers Gap
Quarry Gap
Silver Mine Knob
Ryn
Cem.
LAKE MT. UNION DAM
DOWNSTREAM EXPOSURE MAP
SCALE: 1" = 2000'
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

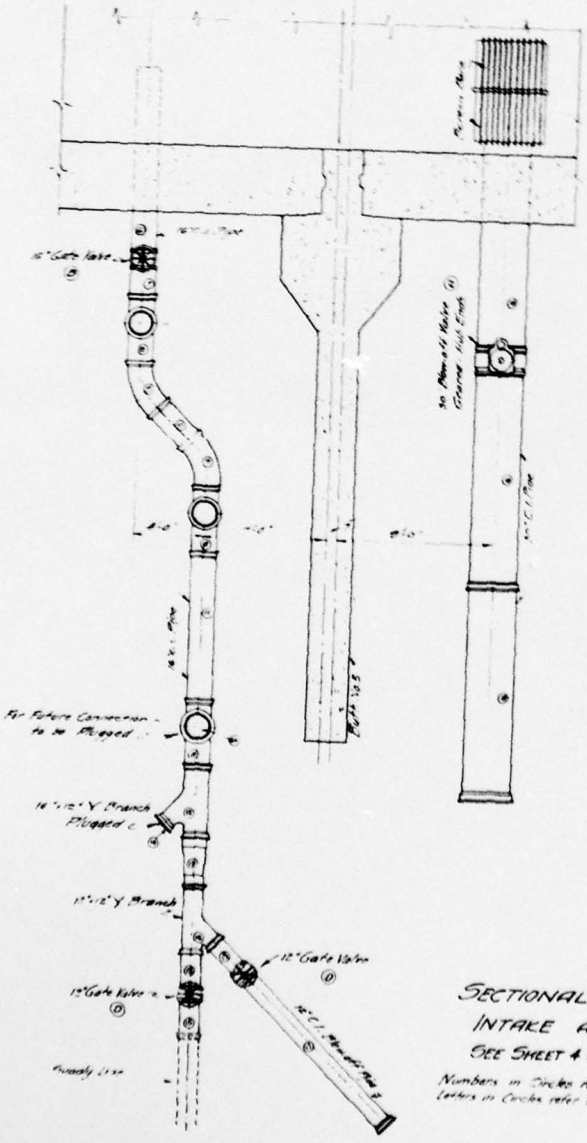
FIGURE 1



PLAN OF DAM



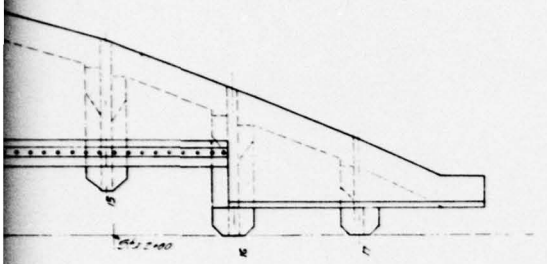
SECTION THROUGH SPILLWAY G-G

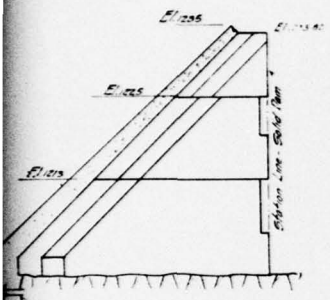


SECTIONAL PLAN OF INTAKE AND BLOW-OFF

SEE SHEET 4 FOR ELEVATION

Numbers in Circles refer to Pipe Schedule
Letters in Circles refer to Valve Schedule





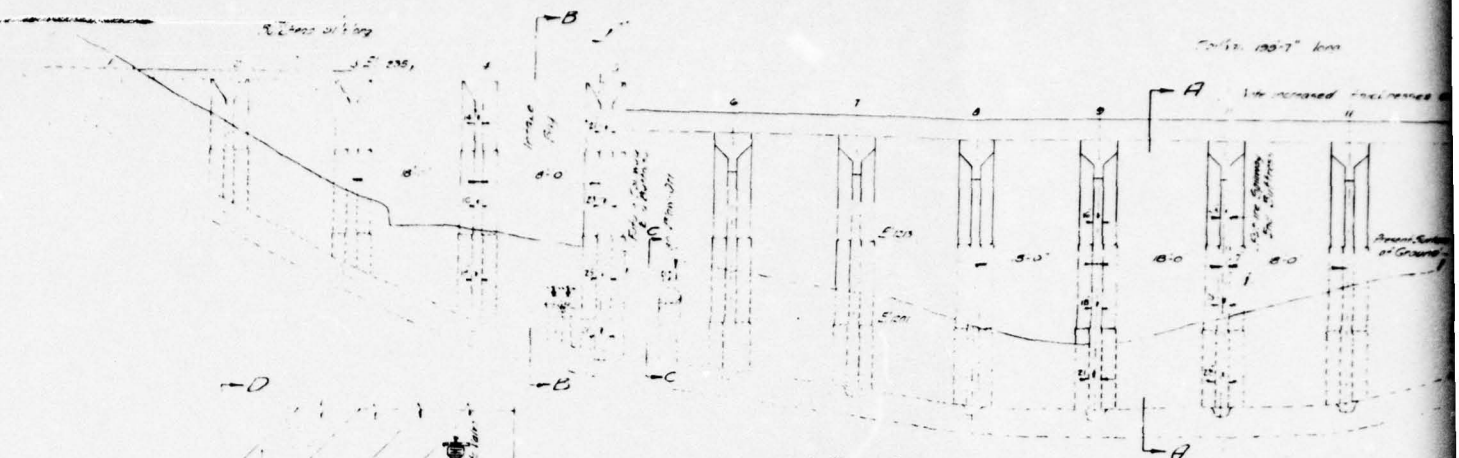
TION THROUGH BULKHEAD H-H

AMBURSEN DAM
FOR
LAKE MOUNT UNION
HUNTINGDON COUNTY - PENNA.
D.W. DILLMAN ENGINEER

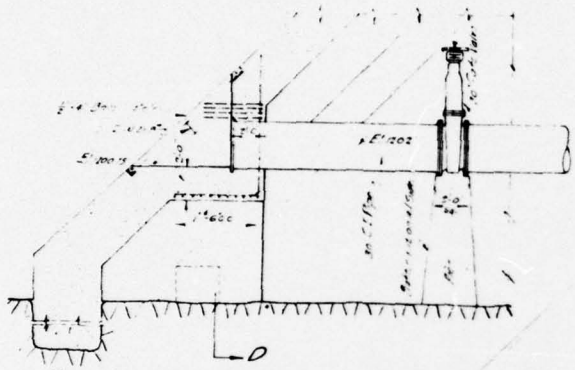
AMBURSEN CONSTRUCTION COMPANY, INC. ENGINEERS - CONSTRUCTORS, NEW YORK		
DRAWN A.Z. 19 54, BY C.I.E REVISED 19 , BY		JOB NUMBER 2510
TRACED 19 , BY 19 , BY		
CHECKED 19 , BY	SCALE 1"=10', 1"=4'	SHEET NUMBER 5 REVISED
APPROVED		

ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

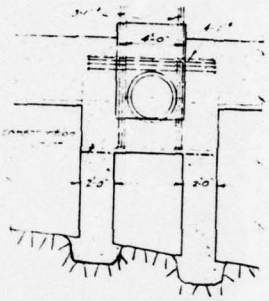
FIGURE 2.



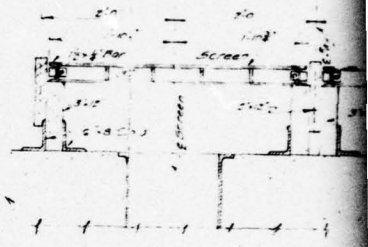
ELEVATION LOOKING UPSTREAM



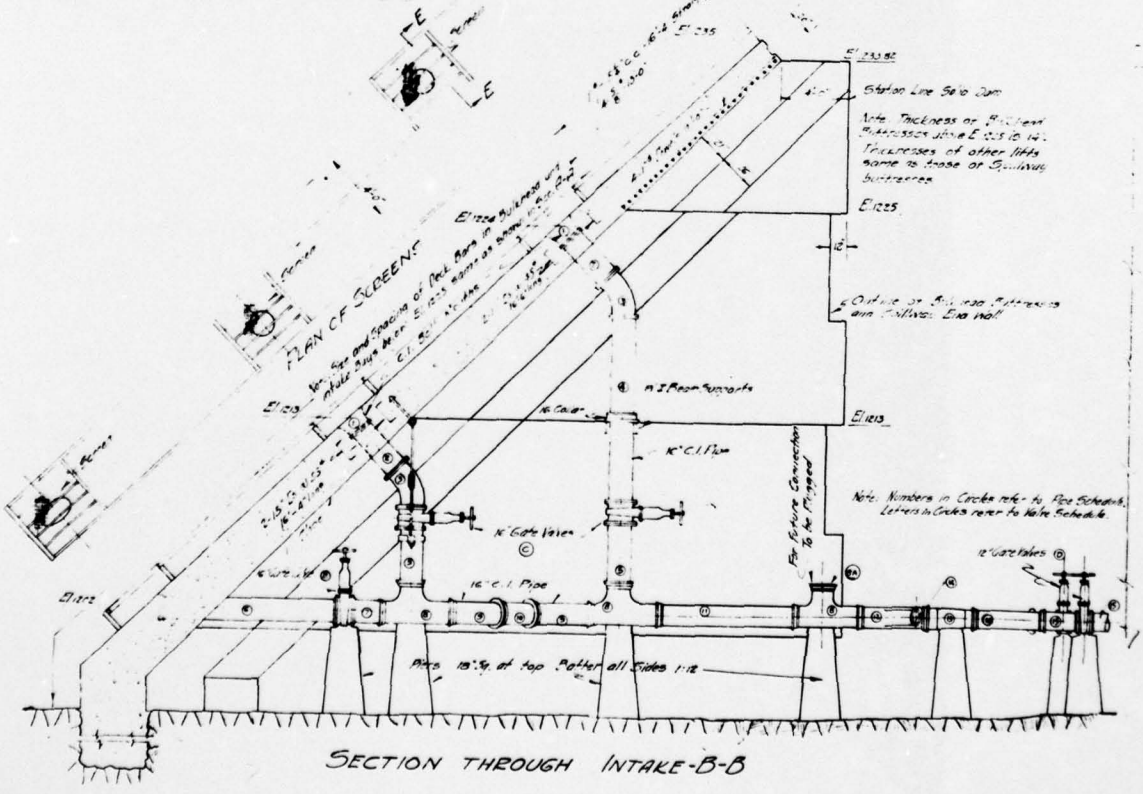
SECTION THROUGH BLOW-OFF C-C



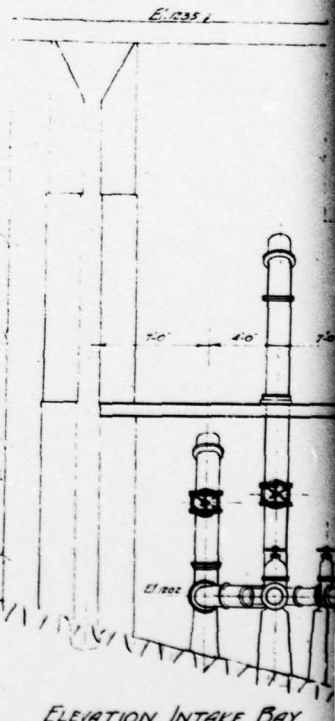
SECTION D-D



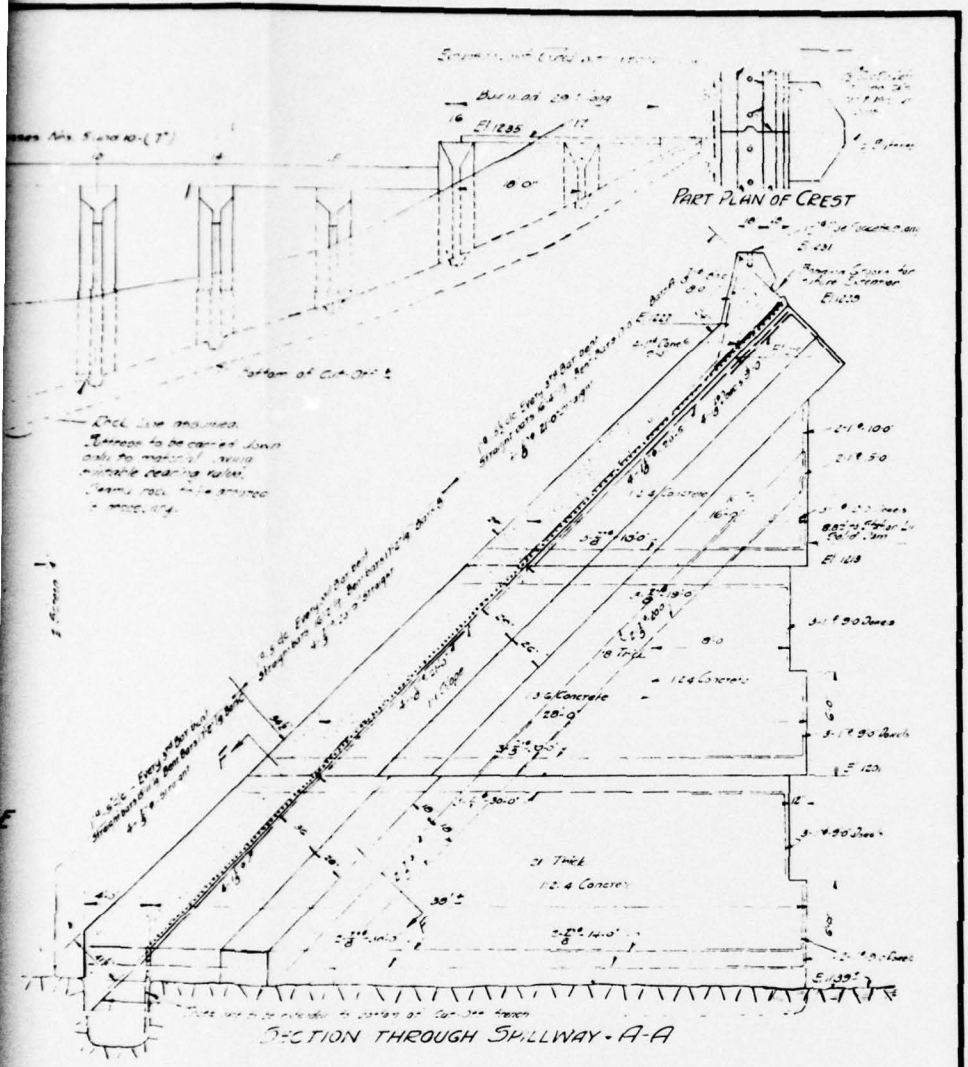
TRANSVERSE SECTION THROUGH SCREE

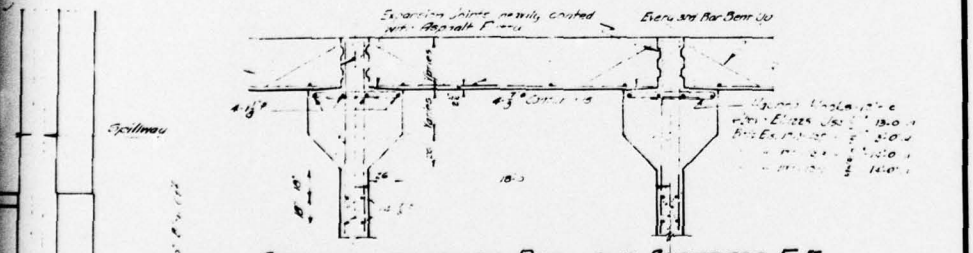


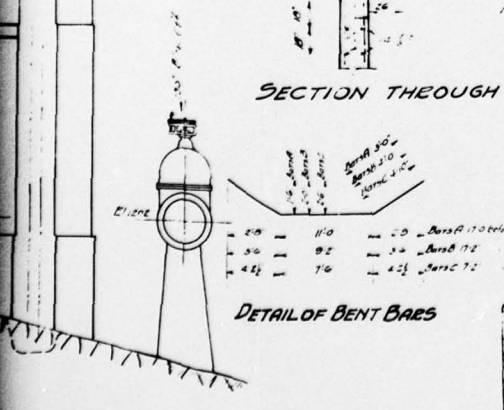
SECTION THROUGH INTAKE-B-B



ELEVATION INTAKE BAY







AMBURSEN DAM
FOR
LAKE MOUNT UNION
HUNTINGDON COUNTY · PENNA.
D.W. DILLMAN ENGINEER

AMBURSEN CONSTRUCTION COMPANY, INC.
ENGINEERS · CONSTRUCTORS, NEW YORK

DRAWN	REVISED	JOB NUMBER 2510
TRACED		
CHECKED	SCALE 1"=10', 1"=4', 1"=1'	SHEET NUMBER 4
APPROVED		

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

2

FIGURE 3

APPENDIX F

GENERAL GEOLOGY

General Geology.

The Mount Union Dam is located within the Valley and Ridge Physiographic Province. This province is typified by numerous synclinal and anticlinal features. Structurally, the dam is located on the western limit of an anticline. No major faulting is associated with this feature. The dam is underlain by Ordovician aged sediments of the Juniata Formation. This formation is composed of red, fine grained, conglomeratic, quartzitic sandstones. The sandstones are cross-bedded and interbedded with red shale.

Geologic Map of Lake Mount Union Dam Area

Mahantango Formation
Brown to olive shale with interbedded sandstones which are dominant in places (Montebello), highly fossiliferous in upper part, contains "Centerfield coral bed" in eastern Pennsylvania.

Marcellus Formation
Black, fissile, carbonaceous shale with thick, brown sandstone (Turkey Ridge) in parts of central Pennsylvania.

Onondaga Formation
Greenish blue, thin bedded shale and dark blue to black, medium bedded limestone with shale predominant in most places, includes Selinsgrove Limestone and Needmore Shale in central Pennsylvania and Buttermilk Falls Limestone and Esopus Shale in easternmost Pennsylvania, in Lehigh Gap area includes Palmerton Sandstone and Bowmanstown Chert.

Dmo

Scale: 1:250,000

APPENDIX G

STABILITY ANALYSIS

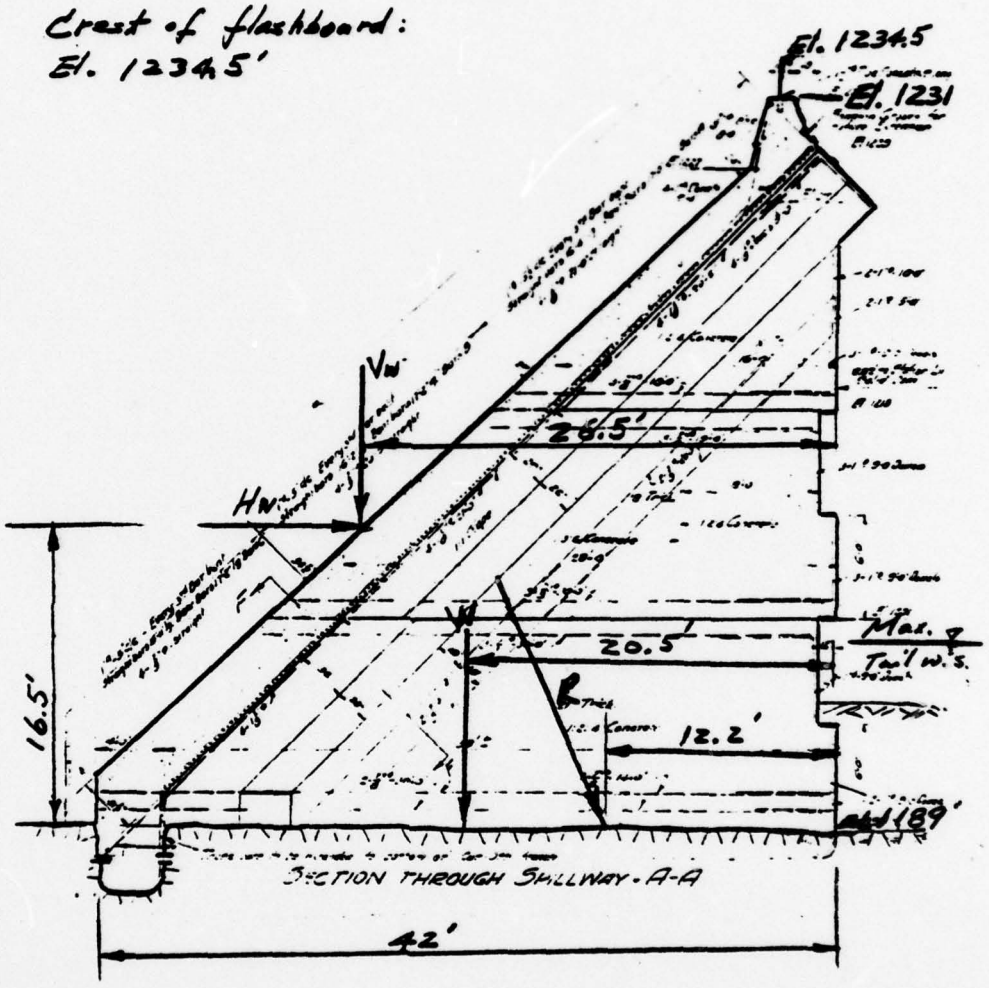
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME Lake Mount Union
I.D. NUMBER
SHEET NO. 1 OF 2
BY KHC DATE 5-15-79

SDF = PMF

Max. H.W. 1239.5'

Crest of flashboard:
El. 1234.5'



(i) Headwater pressure:

	Moment Arm (ft)	M (ft-k)
$V_W = (475+674)(18)(.0624) = 1290^K$	26.5'	+34,185
$H_W = (142+646)(18) = 1418^K$	16.5	−23,400

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME Lake Mount Union
I.D. NUMBER
SHEET NO. 2 OF 2
BY LHC DATE 5-15-79

(ii) Wt. of Structure:

	Mi Arm (ft)	M (ft-k)
Deck wt.: $\frac{1}{2}(24+41.5)(\frac{1}{12})(18)(.150)(56) = 412^{k}$	23.5	+9,680
Buttress: $107+59.4+24 = 190.4^{k}$	13.8	+2,630
$W = 602^{k}$	20.5	+12,310

The headwater uplift pressure on an Ambursen dam is usually insignificant. neglected the tail-water pressure and silt load.

sliding factor, $f = \frac{1,418}{1,290+602} = \underline{0.75}$
(cf. 1189)

Stability against overturning:

$F.S. = \frac{34,185+12,310}{23,400} = \underline{2.0}$

Pt. of Resultant, from downstream face.

$d = \frac{23095}{1290+602} = \underline{12.2'}$ out of Middle third